The Climate of the Cypress Hills: Description of the site and problem

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Introduction

In 1870 after a brief survey, the Dominion Botanist John Macoun wrote (13):

> "In all my wanderings, I never saw any spot equal in beauty to the central plateau of the Cypress Hills. The grasses and other forage plants of the Hills were those peculiar to coolness and altitude, but were all highly nutritious, and most identical with those found on the higher plateau at Morley [an area near Banff]. In all the valleys, and on the rich soil of the higher grounds, the grass was tall enough for hay. No better summer pasture is to be found in all the wide northwest than exists on these hills, as the grass is always green, water of the best quality always abundant, and shelter from the autumnal and winter storms always at hand."

From pioneer days, travellers in the Canadian west looked to The Cypress Hills to provide welcome relief from the rigors of the surrounding prairie. Captain John Palliser noted in 1859 (15):

> "The Cypress Mountains formed indeed a great contrast to the level country through which we were travelling. They are covered with timber ... the soil is rich and the supply of water abundant ... they provide a perfect oasis in the desert we have travelled."

The term "Cypress" was probably first applied by Metis and voyageurs at Chesterhouse near the junction of the Red Deer and South Saskatchewan Rivers. The windblown pines on the high Cypress Hills plateau likely reminded them of similar areas in France where Cypress trees do exist. To the Blackfoot, the region is called "Katewius Netumoo", the "Hills of Whispering Pines". The area is steeped in pioneer lore. It was once a "no-man's land"--a buffer between Blackfoot and Sioux. It was also an ancient hunting ground, a source of timber and of pure, cold water. For 50 years, Canadians, Americans, Indians and half-breeds fought for supremacy in the area, and so it also of necessity became a place of interest to the North-West Mounted Police.

Recently, William Stegner summarized much of the background of the Cypress Hills in his historical narrative, "Wolf Willow"[1]. He related much of what is important historically but left scientific details for others. Geological data and conclusions have been reported by the Alberta Society of Petroleum Geologists (1) and by Russell (17). Detailed maps, with geological and topographical descriptions are contained in these reports, together with complete literature reviews. The Cypress Hills are widely recognized as an erosional remnant (17) (3). Of particular interest is the fact that the gravel and conglomerate capped plateau is non-glaciated. The most recent continental ice sheet came to a halt at the northern edge of the plateau and left there many unusual surface features characteristic of stagnant ice and periglacial activity. To the west and east, the ice ground and groaned its way southward. Recent studies and reports regarding this point have been published by Westgate (18), Jungarius (11) and Broscoe (3).

Biological and ecological surveys have been conducted by Breitung (2), Cormack (5), Godfrey (8), King (12), Rand (16), McConnell (14).

General Climate

The climate of the prairie area surrounding the Cypress Hills is characterized by relatively long, hot, and dry summers, and cold, sharp winters. The effective precipitation is relatively low because of high evaporation rates induced by strong winds and low humidity. At Medicine Hat the hottest month is July with a mean temperature of 70°F (21°C). January is coldest with a mean daily temperature of 19.5°F (-7°C).

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[1] Stegner, Wallace; Wolf Willow, Viking Press Inc., New York 1963; 307 pp.

A high of 109.5°F (43°C) has been recorded and a low of -61.6°F (-52°C). Annual precipitation is 13 inches (33 cm), annual mean winds are westerly at speeds of approximately 16 mph (7 m/second) with a peak in the winter months.

The highest elevation of the Cypress Hills plateau is 4810 feet (1460 m) a.s.l., which is 2730 feet (830 m) higher than Medicine Hat, the nearest principal city, 35 miles (56 km) to the north-west. The plateau lies 1500 to 2000 feet (450 to 600 m) above the average surrounding prairie terrain. Although reliable climatic data from the Cypress Hills region are singularly lacking, it is estimated that the daily mean temperature for July is 59°F (15°C) with an average annual precipitation in excess of 20 inches (50 cm). The effectiveness of this rainfall is enhanced by the reduced evaporation rate. Hence the vegetation is more luxuriant and many slopes, particularly the northern scarp, are covered with dense, mixed deciduous and coniferous forests. Two main vegetational divisions have been suggested (2): 1) the forest, which is almost entirely restricted to north slopes and inner-plateau valleys and 2) the grassland, which covers the remainder including the almost treeless summit plateau.

The transition between the divisions at the summit is very abrupt. Elsewhere at lower elevations, snow accumulation in ravines and coulees provides the moisture that allows trees and shrubs to encroach considerable distances onto the grasslands.

Research Problem

Few natural areas provide such an excellent opportunity to study climatic-topographical-biological relationships as do the Cypress Hills. The formation is relatively small (15 x 150 miles)(24 x 240 km)

and hence research logistics are simplified. The hills rise relatively abruptly and are almost completely surrounded by the prairie, producing a convenient but unique island-oasis. Figure 1 presents a westerly view of the northern escarpment with the abrupt transition from forest to non-forest land. Figure 2 shows a north-easterly view from near the summit plateau, overlooking Elkwater Lake, to the prairie. Figure 3 illustrates sharp discontinuities in vegetation on a westerly slope up to the summit plateau. Figure 3a presents a view of the westerly end of the Cypress Hills and low scattered fair-weather cumulus are seen forming from orographic lift.

In this area many detailed studies are possible to clarify relationships between the atmosphere and the surface. The atmospheric boundary layer adjusts to the increase in surface elevation and also to the changing physical characteristics of the surface. Although many problems await our attention, present studies are directed toward 1) quantitative comparison of the climate of the Cypress Hills with that of the surrounding prairie, 2) determining the climates that exist within the Cypress Hills complex, 3) relating quantitatively the various climates to the topography, with a view to clarifying phenomena in the boundary layer as the surface increases in elevation. Instrumentation is located: 1) at 8 surface sites which are believed to present distinct and representative climatic situations, 2) in an aircraft which provides for the extension of surface observations upward as high as the effect of the Hills can be measured. Additional data are being obtained from the weather observation stations of the Department of Transport at Lethbridge, Manyberries, and Medicine Hat, Alberta, and Swift Current, Saskatchewan.

Observational Sites

Eight observing stations have been established in the Alberta portion of the Cypress Hills, and in the prairie to the immediate north and south. Sites were chosen that would provide data from the general area of maximum relief and would be representative of major kinds of terrain encountered in the Cypress Hills and vicinity. In this work, it is

Figure 1 A westerly view of the northern escarpment of the Cypress Hills. Note the abrupt change from forested to non-forested surface. Elkwater Lake is seen partially hidden by hills and the Wisconsin terminal moraine is seen stretching from the base of the escarpment to the north (right of the picture).

Figure 2 A northeasterly view from near the summit of the Cypress Hills overlooking Elkwater Lake, the Wisconsin terminal moraine, and prairie to the north. Note the dense mixed forests and the sharp transition to grass covered hilltops.

Figure 3 Summit plateau of the Cypress Hills looking northeast. This is the highest point of the entire formation. Note the treeless grasslands on the plateau and the forested slopes.

Figure 3a The western end of the Cypress Hills showing the elevated terrain sloping and merging into the prairie to the west. Scattered cumulus are forming as a result of orographic lift as wind moves from west to east or from top to bottom of picture.

assumed, for example, that measurements made at the site on the forested north slope would be similar to measurements made elsewhere in the Cypress Hills on forested north slopes. Figure 4a and 4b show the location of the Cypress Hills in relation to other broader geographical features and also presents a topographical map of the entire Hills complex. Figure 5 is an enlarged map of the Alberta study area, showing the location of the 8 observing sites. The four sites that are considered to be most important are circled. These sites provide a complete sampling of surface weather in a NW - SE transect from north of the plateau, over the plateau and to the south. They are the most heavily instrumented. The remaining four stations are designed to obtain data to show the degree of horizontal variation along the summit plateau, and to determine the climatic transition from a forested to a non-forested situation. Table 1 presents an outline of the type of weather observations taken at the 8 sites. Each site is surrounded by a barbed-wire fence to keep out wild game, stock, and tourists.

Site Description

(numbers correspond to those in figure 5)

1) Summit Bench Mark: 4725 feet (1420 m) a.s.l.; north latitude, 49°37'45"; west longitude, 110°16'15".

This is the central observational site of the study. It is located on the summit plateau surface with a wide and open exposure in all directions; it lies approximately 100 feet (33 m) below the highest point in the Cypress Hills. Figure 6 shows a north-east view. All measurements will be related to those taken at this site, because of the representative exposure of the extensive high plateau. The soil supports luxuriant growth of grass, with a mat of organic matter 1 inch (2.5 cm)

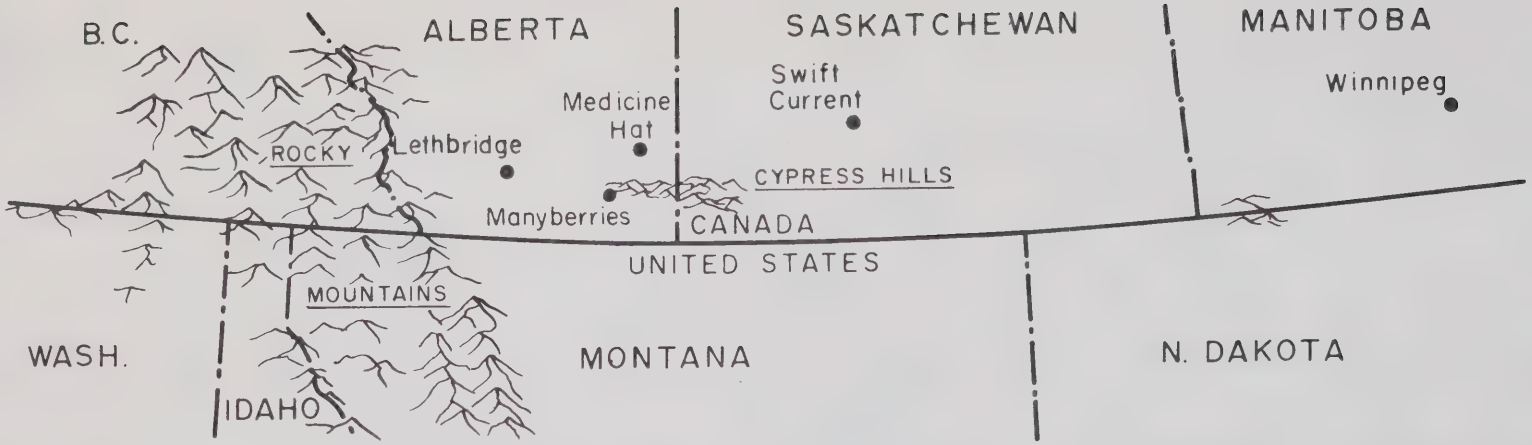


FIG. 4A. LOCATION OF CYPRESS HILLS IN RELATION TO OTHER GEOGRAPHICAL FEATURES.

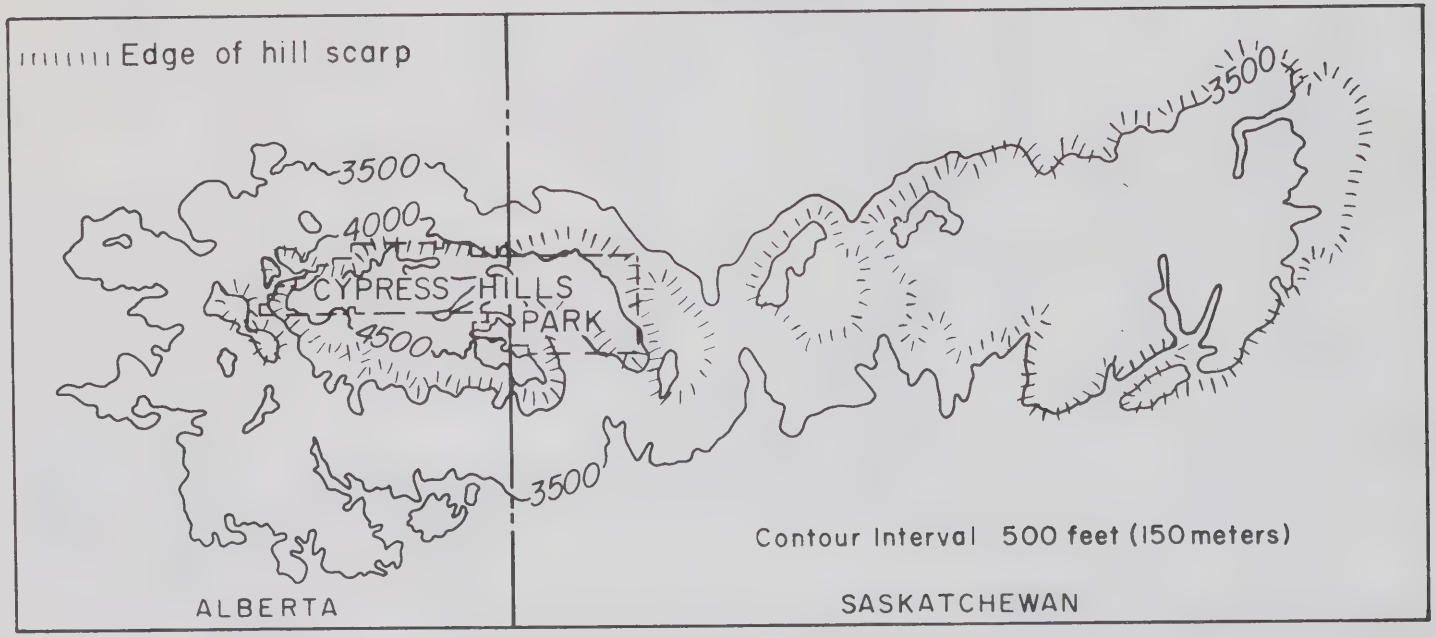


FIG. 4B. TOPOGRAPHICAL MAP OF ENTIRE CYPRESS HILLS COMPLEX.

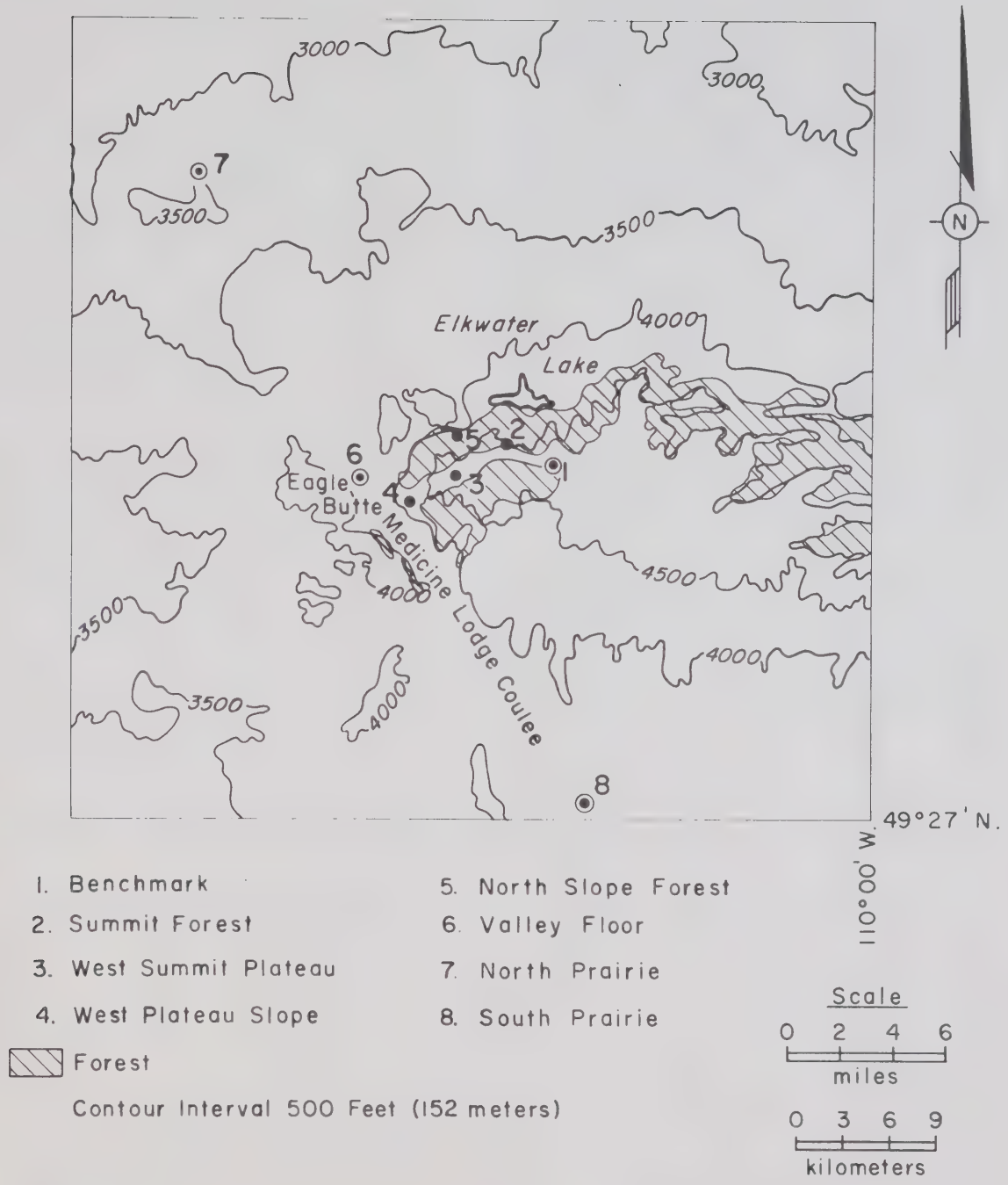


FIGURE 5

ENLARGED SECTION OF ALBERTA STUDY AREA OF CYPRESS HILLS SHOWING LOCATION OF SURFACE OBSERVATION SITES

Table 1

Weather Observations at 8 Sites in the Cypress Hills

Observation	Observing Site							
	Summit Bench Mark	Summit Forest	West Summit Plateau	West Plateau Slope	North Slope Forest	Open Valley	North Prairie	South Prairie
Daily Maximum Temperature (1)	X	X	X	X	X	X	X	X
Daily Minimum Temperature (1)	X	X	X	X	X	X	X	X
Grass Minimum Temperature	X	X	X	X	X	X	X	X
Standard Rain Gauge (4)	X	X	X	X	X	X	X	X
Tipping Bucket Rain Gauge	X					X	X	X
Totalizing Anemometer (2) (4)	X	X	X	X	X	X	X	X
Anemograph (wind speed & direction) (3)	X						X	X
Hygrothermograph (1)	X	X	X	X	X	X	X	X
Sling Psychrometer (4)	X	X	X	X	X	X	X	X
Black Porous Disc Atmometer (4) (9)	X				X	X	X	X
Class "A" Evaporation Pan (4) (5)	X					X	X	X
Soil Temperature (4 & 8 inch "L" thermometer) (6)	X	X	X	X	X	X	X	X
Soil Temperature (7)	X							
Snow Fall (8)	X						X	X

(1) Screen height 1-1/2 meters
(2) 2 Meters
(3) 10 Meters
(4) Observed at 0800 and 1700 hrs.
(5) Complete with water temperature and anemometer at pan rim height.
(6) Observed at 0800 and 1700 hrs.
(7) 5 cm, 10 cm, 20 cm, 50 cm, 150 cm and 300 cm observed at 0800 and 1700 hrs.
(8) Sacremento gauge and Knipfer shield, 3 Meters
(9) 1-1/2 Meters

thick. The soil is formed on loess, with well defined horizons. The A horizon is black, with a high organic-matter content, and 13 inches (30-35 cm) deep. The C horizon is lighter in color with coarse gravel.

2) Summit Forest: 4760 feet (1450 m) a.s.l.; north latitude, 49°38'0"; west longitude, 110°17'40".

This site is assumed to be representative of areas on the summit plateau under forest. The data provide an estimate of the effect of forest on the summit climate. The canopy is even and regular and the stand of lodge-pole pine is uniform with no understory. The observation point is shown in figure 7 looking north-east. The forest litter is a dense mat of needles about 2 inches (5 cm) thick. The soil is a dense silty clay loam, poorly drained, with no horizons discernible. The soil material is yellowish-brown with a thin layer of dark, decomposing organic matter at the surface. Pebbles and rocks are distributed throughout the horizon.

3) West Summit Plateau: 4780 feet (1455 m) a.s.l.; north latitude, 49°37'15"; west longitude, 110°22'20".

This site is about 30 feet (9 m) below the highest point of the plateau. Figure 8 shows the area looking west. In the distant right, a Ranger look-out tower marks the highest point in the Cypress Hills. The site is exposed in all directions and will provide an opportunity for determining the horizontal variations of climate along the plateau, west to east. The soil is covered by a luxuriant growth of grass with a dense mat of organic matter 1 inch (2.5 cm) thick. The soil is formed on loess with no pebbles or rocks except in the C horizon. The A horizon is black, 12 inches (30 cm) deep, and high in organic-matter content.

Figure 6 Bench Mark observation site looking north. This is the central observing site of the study. Trees in the distance mark the location of the northern edge of the summit plateau which slopes to the north.

Figure 7 Summit forest observational site. Forest is an even stand of lodge-pole pine with no understory.

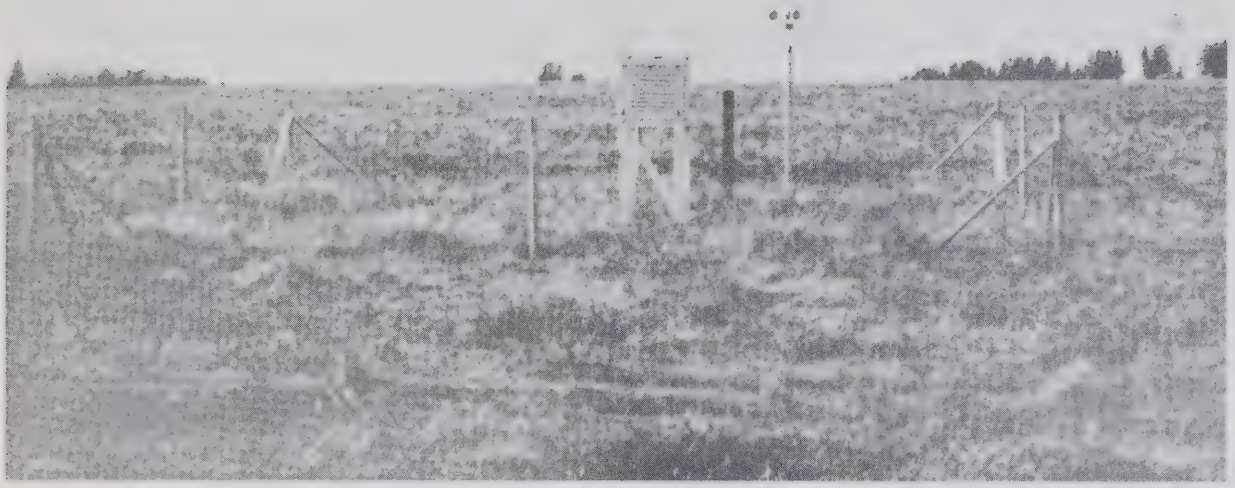


Figure 8 West summit plateau observational site. This westerly view shows the summit point at the ranger lookout tower in the distant right. The centre horizon is 500 yards from the site and begins to slope downward to the west at that point.

4) West Plateau Slope: 4530 feet (1380 m) a.s.l.; north latitude, 110°23'10"; west longitude, 49°36'45".

This site is about 300 feet (90 m) below the highest point and is exposed in all directions. Figure 9 shows a south-westerly view. The soil supports a lush growth of grass with a mat of organic matter 2.5 cm thick. This site is representative of many down-slope plateau areas, and the data will be used mainly to investigate the transition to valley areas, and for air drainage studies. The soil is silty clay loam with well defined A and B horizons. The A horizon is dark and approximately 7 inches (15 to 20 cm) deep, with high organic-matter content. Pebbles and rocks are distributed throughout with heavy coarse gravel in the C horizon.

5) North Slope Forest: 4125 feet (1250 m) a.s.l.; north latitude, 49°37'35"; west longitude, 110°22'45".

Most of the forest in the Cypress Hills is located on the northern escarpment. This site is considered to be representative of the north forested-slope condition. Figure 10 shows the observation site looking west. The forest is mixed deciduous and coniferous, with an uneven and irregular canopy. Large open areas, devoid of trees, are the result of local farmer logging and beaver activity. The forest litter consists of thickly matted pine needles and aspen leaves, and is about 1-2 inches (2.5 to 5 cm) thick. The soil is a poorly drained dense clay loam with few rocks and pebbles. The horizons below the A can not be distinguished because of solifluction.

6) Open Valley: 3680 feet (1120 m) a.s.l.; north latitude, 49°37'30"; west longitude, 110°26'10".

Figure 11 shows a south easterly view of the Valley site looking toward the forest on the north slope where site number 5 is located. Notice the marked slumping on the northern slope. The Valley site

Figure 9 West plateau slope observation site. The distant right horizon shows prairie to the west. Note the forest which is mainly restricted to the slopes.

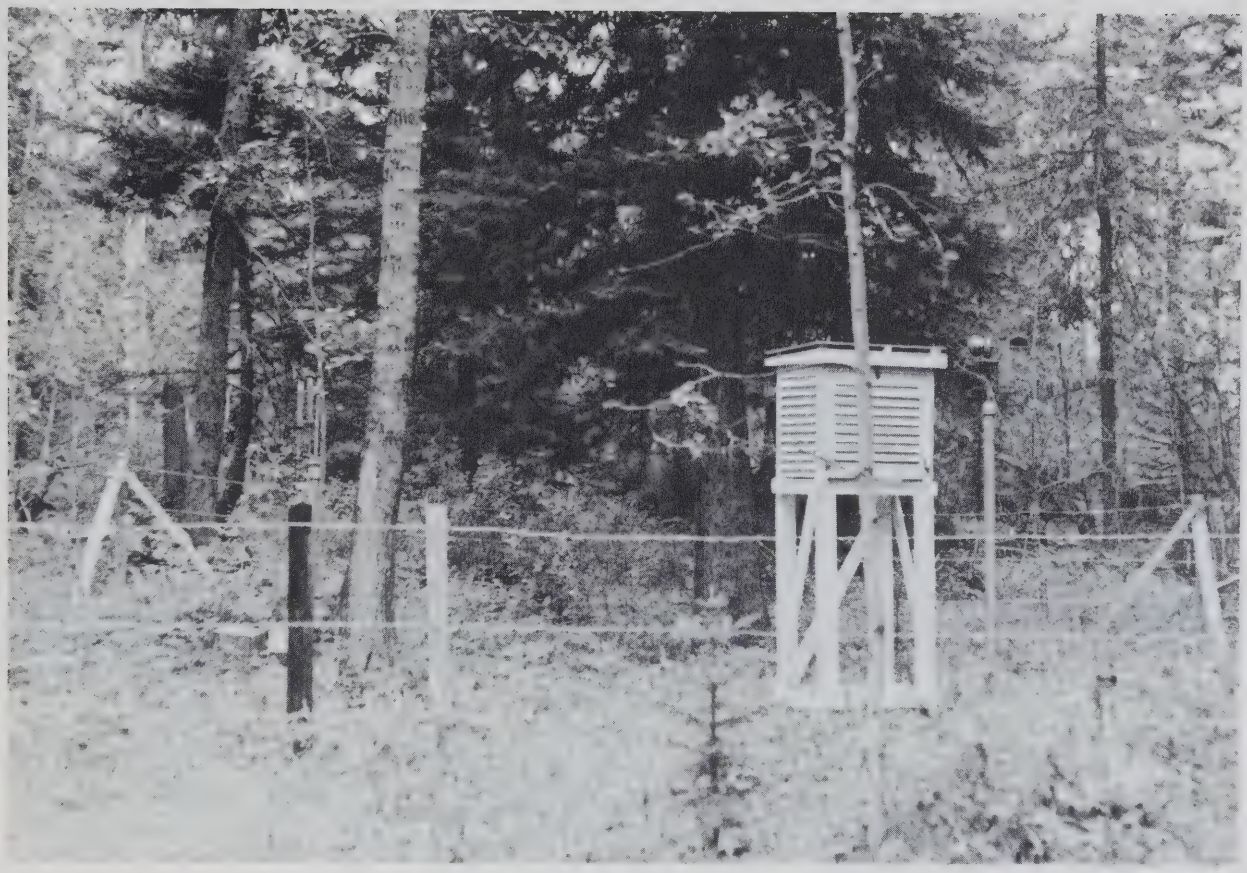
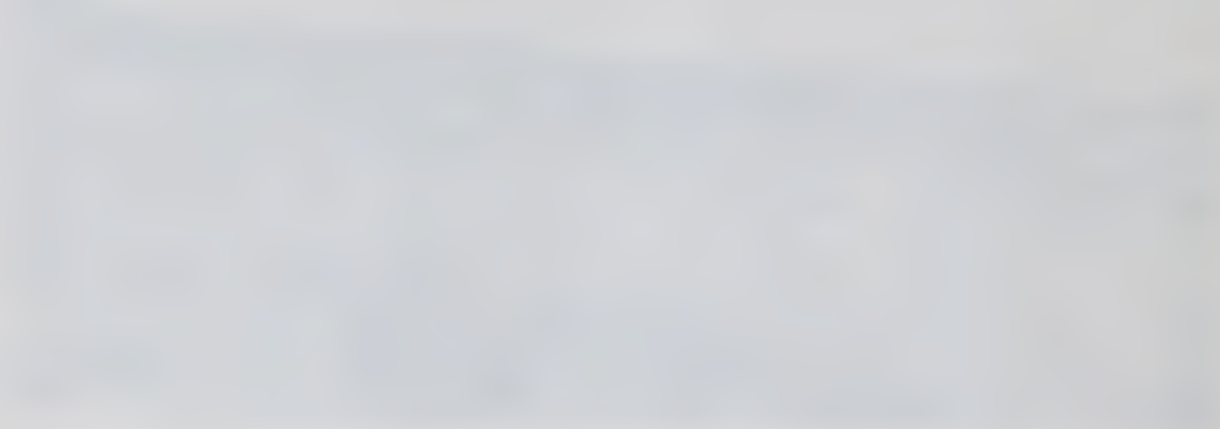


Figure 10 North slope forest observational site. Area is representative of forests on the northern escarpment. The forest has open and uneven canopy with mixed deciduous and coniferous trees.

Figure 10a Heavily forested northern slope with pasture in the valley bottom watered by groundwater discharge along the slope. Note the distribution of coniferous and deciduous trees with conifers predominating at higher elevations.

Figure 11 Open Valley observational site. Notice the heavy forests and soil slumping on the northern slope. Forests are restricted to the upper elevations of the slope; valleys are markedly more arid than the slopes.



is typical of many similar valleys and river-bed areas in the Cypress Hills. The site is exposed on all sides. The soil supports a moderate growth of grass but not as luxuriant as on the plateau. The soil is an alluvial clay loam with coarse gravel thinly distributed throughout the horizons.

7) North Prairie: 3475 feet (1055 m) a.s.l.; north latitude, 49°45'00"; west longitude, 110°34'20".

This site represents prairie exposures to the north of the Cypress Hills. It is located near the northern edge of the terminal moraine approximately midway between the summit high point and Medicine Hat. It is exposed on all sides with open prairie descending gradually to the north. Figure 12 shows a view of the site looking to the north over the prairie. The soil supports sparse growth of prairie grass with a thin prairie mat of organic matter, moss and lichens. The soil is a silty clay loam on glacial till, with coarse gravel throughout the various horizons. Horizons are poorly differentiated with a C horizon at 18 inches (46 cm).

8) South Prairie: 3780 feet (1160 m) a.s.l.; north latitude, 49°27'0"; west longitude, 110°15'00".

Figure 13 presents a northerly view of the south prairie site looking toward the highest point of the Cypress Hills which are visible in the distance. The site is exposed to open prairie on all sides and the soil supports sparse prairie grass and a thin prairie mat of organic matter, lichens and moss. The site is in every way representative of the general south region of the Cypress Hills. The soil is a silty clay loam on glacial till, with coarse gravel throughout the horizon. The C horizon is approximately 18 inches (45 cm) deep.

A more detailed description of Cypress Hills soils is available from Gravenor et al. (9), Jungarius (11), and Wyatt et al. (19).

Figure 12 North prairie observational site. Norther prairie extends into the background, while site is located near the northern edge of the Wisconsin terminal moraine. This area is representative of the entire area to the north of the Cypress Hills.

Figure 13 South prairie observational site. Cypress Hills forests and summit plateau are visible in the distance to the north. This exposure is representative of the general area to the south of the Hills.

Observational Schedule

Observations of surface weather are carried out throughout the year. During the summer period each site is visited twice daily to examine all instruments for proper performance and to make observations. All data are taken in a standard manner, in accordance with the Canadian Department of Transport Manual of Observation. This schedule begins as soon as snow melt is sufficient to make the country roads passable. The twice-daily visits are discontinued about September 1. During the intervening winter months the sites are visited weekly to change the hygrothermograph charts, and to observe snowfall, weekly miles of wind, and snow on the ground. A snow vehicle is required for most of these visits. Frequently conditions become very bitter during winter months, with much snow, blowing and drifting snow, and low cloud. Clogging of the Stevenson Screens with fine snow is frequent with stoppage of the clocks, and v-lever linkages on the hygrothermographs. The hair of the hygrometer becomes coated with snow or frost with a subsequent continual indication of 100% relative humidity. This condition persists until an observer cleans the instrument or the frost accumulation on the hairs sublimes. Only then does the instrument perform properly. This results in a frequent loss of data and no solution is yet available.

The airborne observations are made using an instrumented Piper Cherokee "6" (Pa-32-300). It is possible to measure intermittently or continually, air and surface temperature, air dew point temperature, albedo, solar and sky short-wave radiation, reflected short-wave radiation, and three vectors of air movement. A detailed description of the instruments and data acquisition system will be published at a later date. The aircraft

contains a radio altimeter which permits accurate determination of distance between the aircraft and ground surface. Over flat terrain, altitudes of 50 feet (15 m) can be accurately maintained with safety. Over hilly areas experience has shown that the minimum safe altitude is highly dependent on wind speed and direction. Therefore a constant density-altitude is flown rather than maintaining a fixed distance between aircraft and surface. The aircraft has been found to have enormous capability to extend meteorological observations upward into the atmosphere. Further, a large horizontal coverage is possible in a short period of time. Figures 13a, 13b and 13c, show the aircraft and some of the instruments and mountings on the wings and fuselage.

Preliminary Results

(a) Surface: It is anticipated that surface observations will continue as outlined above for 8 - 10 years. This period of time is required to sample a sufficient number of seasonal situations to be confident that the data are representative, reliable and complete. Analysis of data will be performed at frequent intervals to maintain a continuous appraisal of weather patterns and events in the study area. Climatic models will be developed and tested using the data as it becomes available.

Several comparisons were made between the climate at the north Prairie site and the plateau summit. Figure 14 presents a situation observed on a warm day following a period of rain. It is to be noted that the Hills are cooler and more moist than the prairies. Air temperature was generally lower and had less diurnal variation on the plateau. This was also true of soil temperature at 4 inches (9 cm). Air

Figure 13a Piper Cherokee (Pa-32-300) "6" aircraft used in boundary layer studies in the Cypress Hills.

Figure 13b Airborne psychrometer on left wing of Pa-32-300. This instrument measures the dew point temperature, dry bulb temperature and wet bulb depression temperature of the air with a time constant of about 0.1 seconds. The casing contains water supply, 0°C reference temperature, and all associated electronics for the instrument.

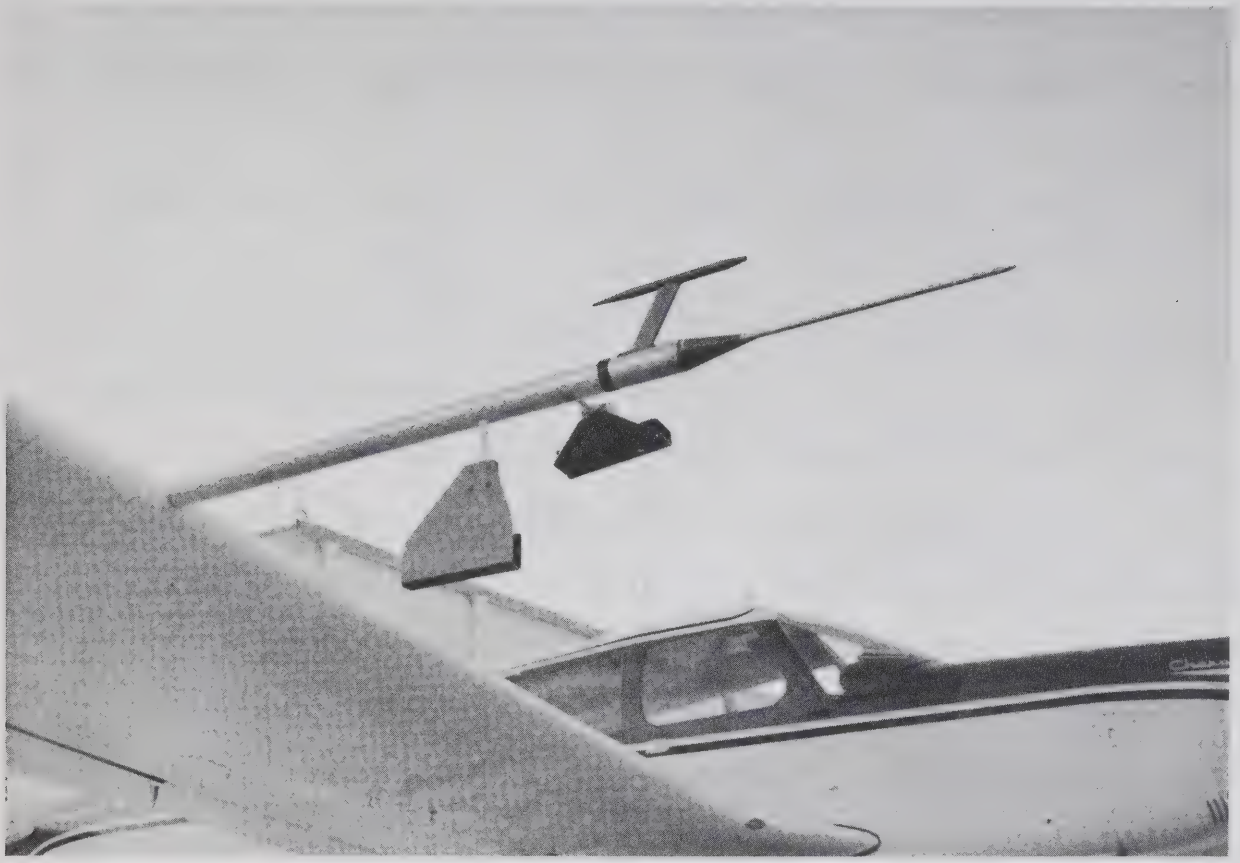


Figure 13c Air turbulence probe on Cherokee Pa-32-300. Instrument measures the three components of air movement, using vanes concealed within the guards. Probe also has dynamic and static pressure measuring devices, as well as the 3 directional acceleration of the aircraft. Also in the probe is a 3-axis rate gyro system to sense the aircraft attitude.

vapour pressure was always higher on the plateau due to a higher soil moisture content. The high temperature of the soil surface on this day can be appreciated by noting the temperature of vegetation near the surface. The plant chosen for this measurement was artemesia, about 1-1/2 inches (4 cm) high. Small thermocouples of 32 gauge wire were threaded into the stem midway up the plant. Thermocuple output was measured with a portable potentiometer. An unusual 123°F (51°C) was achieved on the prairie while only 89°F (32.5°C) was measured at the same time on the summit plateau.

Air flow over the Hills was qualitatively determined by smoke-tracer tests on three separate days when winds were from the west. A summary of findings from these intermittent tests is presented in figure 15. An oil fog generator and chemical smoke pots were placed at the various positions indicated, to determine air flow near several prominences. It is to be noted that figure 15 is diagrammatic and air streams were drawn from photographs. The figure is presented to show the complex nature of westerly flow over the Hills. Of particular interest is the existence of a well defined rotor in the valley when wind speeds were in excess of 7 - 9 mph (18 - 20 m/second). At 4 - 5 mph (8 - 10 m/second) and less, wind flow followed the contours of the valley. Over the plateau less well defined rotors would form and then break up at the positions indicated when wind speeds were in excess of 7 - 10 mph (18 - 20 m/second). Wind tunnel testing of models of the terrain is contemplated as part of future experimentation. Wind flow and patterns over the Cypress Hills is considered to have a marked effect on moisture and vegetation distribution. Also, areas of enhanced or reduced rainfall, drifting of snow, evaporation patterns, air drainage, inversion formation are related to air flow characteristics.

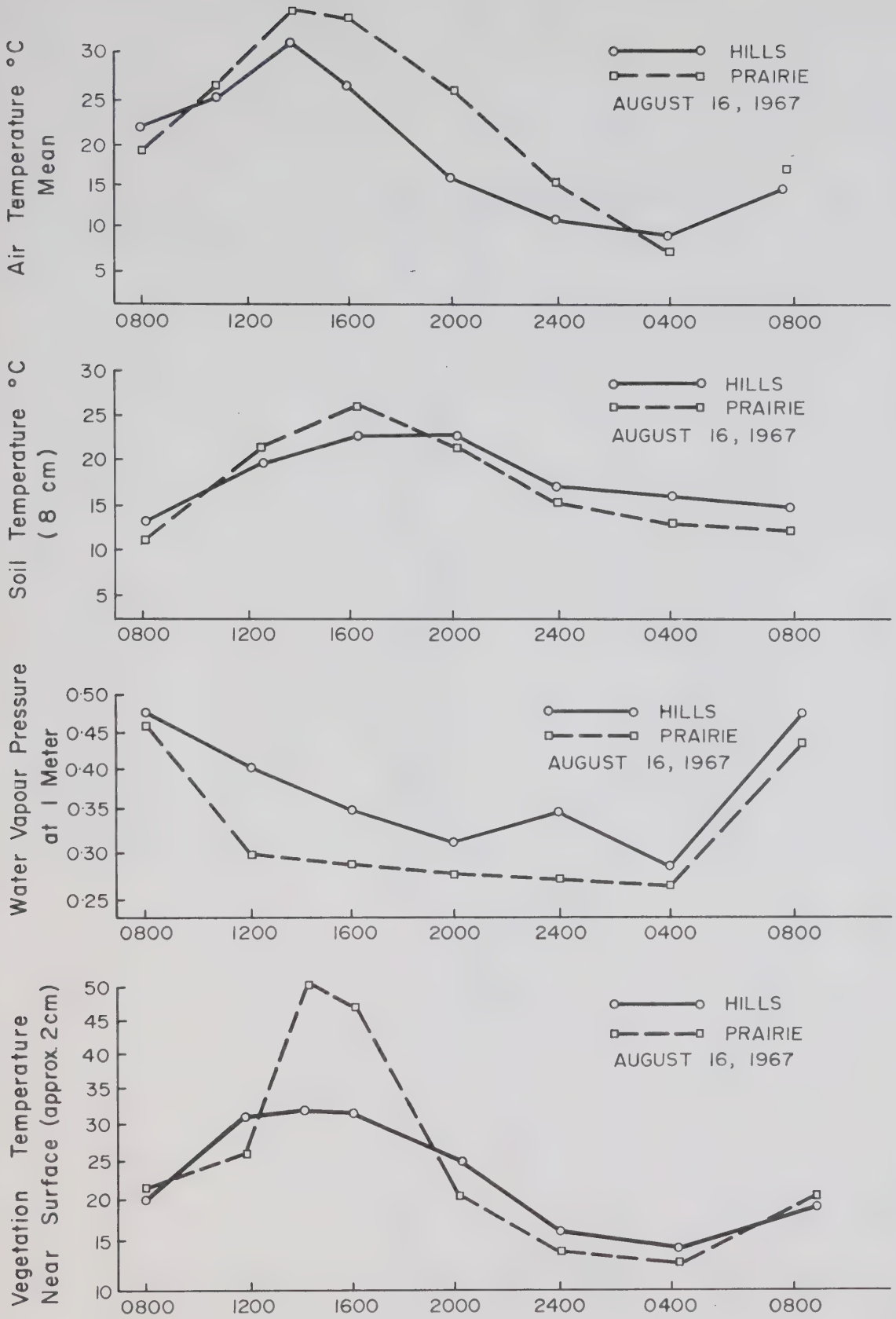


FIGURE 14 COMPARISON OF CLIMATIC VARIABLES AT CYPRESS HILLS BENCH MARK SITE AND NORTH PRAIRIE SITE FOR AUGUST 16, 1967

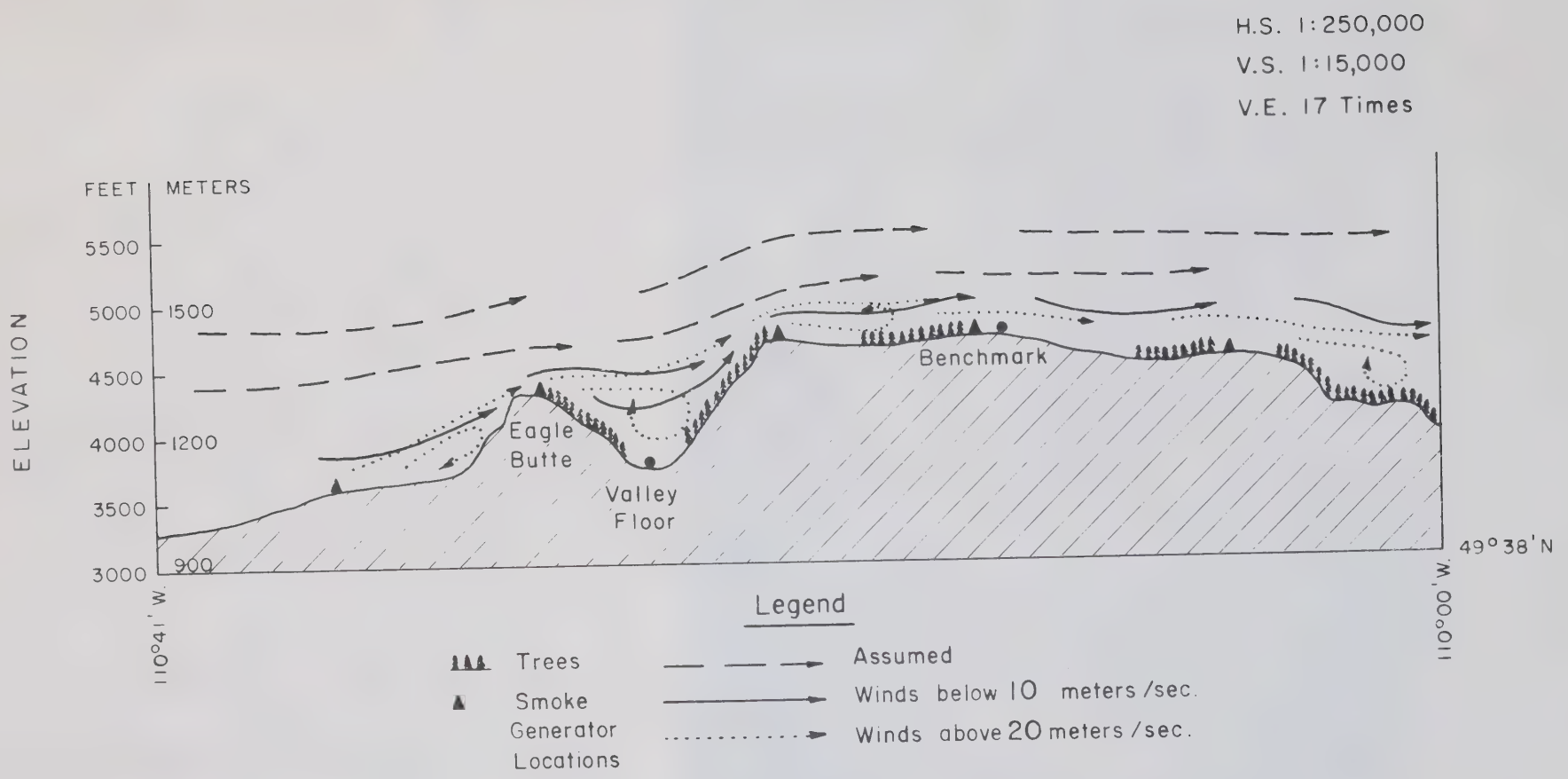


FIG. 15

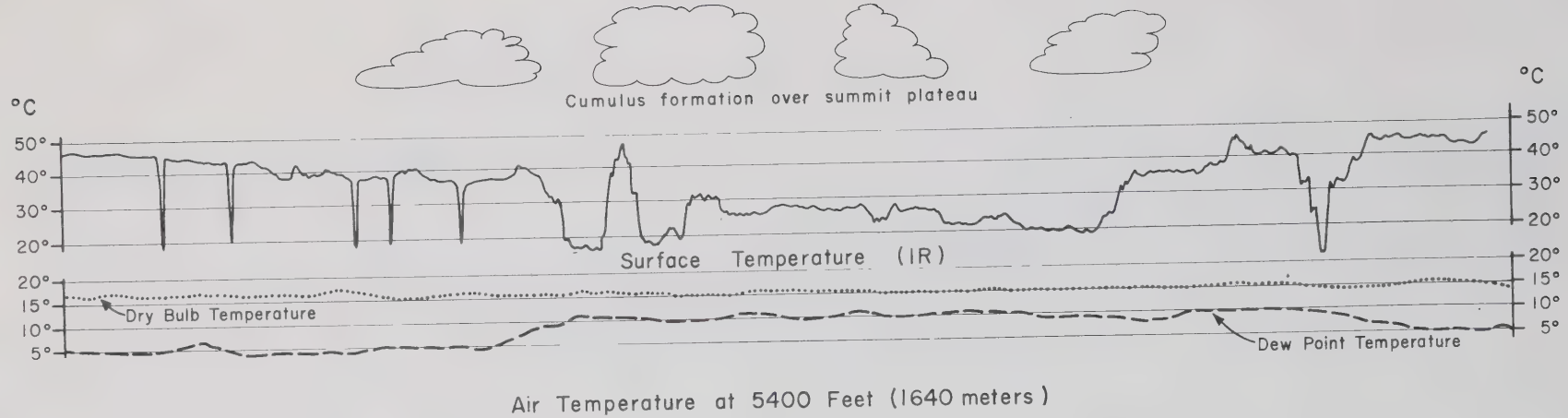
WEST - EAST CROSS - SECTION OF CYPRESS HILLS WITH SCHEMATIC REPRESENTATION OF WIND FLOW DEDUCED FROM SMOKE TRACER TESTS.

Figure 15a Oil fog plumes from three generators slowly flowing down hill into the valley in early evening. Notice the different directions of air drainage of each plume and wind shear on the plume to the right. Geostrophic wind flow was from right to left but a valley rotor caused shear from left to right on the plume.

(b) Airborne: During the first season of this study, the aircraft instrumentation was incomplete and only a few data are available. In figure 16 observations of surface temperature taken with an infra-red thermometer are presented. All readings are corrected for surface emissivity. Emissivity was approximated using a larger device but methods similar to those of Fuchs and Tanner (6) (7), and Buettner and Kern (4). The emissivity of dry virgin prairie surfaces was found to vary from .94 to .96 depending on the sparseness of vegetation. A value of .95 was used for these surfaces. Tall green prairie grass 4 - 6 inches (10 - 15 cm), that completely covered the ground at higher elevations near the Cypress Hills, had an emissivity of .95 to .97 depending on the density of the grass vegetation. A value of .96 was used. Emissivity values for forest were estimated from those obtained from very tall, green grass 20 inches (50 cm) with a bunchy canopy, which varied from .96 to .98. A value of .97 was thus adopted for forest. Bare soil surfaces were not encountered over this particular ground track but elsewhere emissivities varied from .91 to .94 depending on soil texture. The heavier soils tended to have the higher emissivities. Emissivity for water was taken as 1.0 although this value may be too high (6) (7). The instrument chart trace was examined and points were taken at 5 second intervals. The ground track was examined for type of terrain and the appropriate emissivity was applied and a new graph plotted. The corrected graph is shown in figure 16.

It is to be noted from figure 16 that the surface is highly variable in temperature with occasional sharp decreases on the approach to the Hills from Medicine Hat. These variations are caused by small lakes and sloughs. On this day the surface temperature gradually decreased as the surface elevation increased. An unusual 118°F (48°C)

was measured at the Valley site despite the elevation. Over the summit toward the south the coolness of the forest and plateau meadow compared with the south prairie area is noteworthy. Air temperature is seen to remain relatively uniform at 5400 feet (1620 m) which is approximately 400 feet (122 m) above the plateau. However dew point temperature shows a uniform increase at this height, then decreases beyond the Hills to the south. This particular effect is more noticeable in figure 17. Dry bulb temperatures at 5200 feet (1550 m) remain relatively uniform over the Hills and increase during day time heating. There is a slight effect of the Hills in air temperature at 0800 MST with residual nocturnally cooled air over the plateau. A suggestion of daytime heating is also noted near the Hills at 1200 and 1600 MST. However, as the day proceeded a marked increase in dew point temperature occurred over the area and to the south. On another day following a period of rain similar measurements were made in a vertical profile. These data are shown in figure 18. Transects were flown over the same ground track as that of figure 17 at 100 feet (30 m) elevation intervals beginning at 5000 and continuing to 6800 feet (1520 - 2060 m). The lines of equal dew point temperature show a marked "Hills-oasis effect" which persists for a considerable distance downwind, suggesting a "moist air plume" rising from the plateau and forest and extending downwind before diffusing into the ambient prairie atmosphere. Similar results were obtained by Holmes over prairie lakes in the same area (10). The airborne observations illustrated here represent selected situations. It must be emphasized that the observed effects were found to be highly variable when taken over a number of days. On many days no effects could be measured regardless of altitude or time of day.



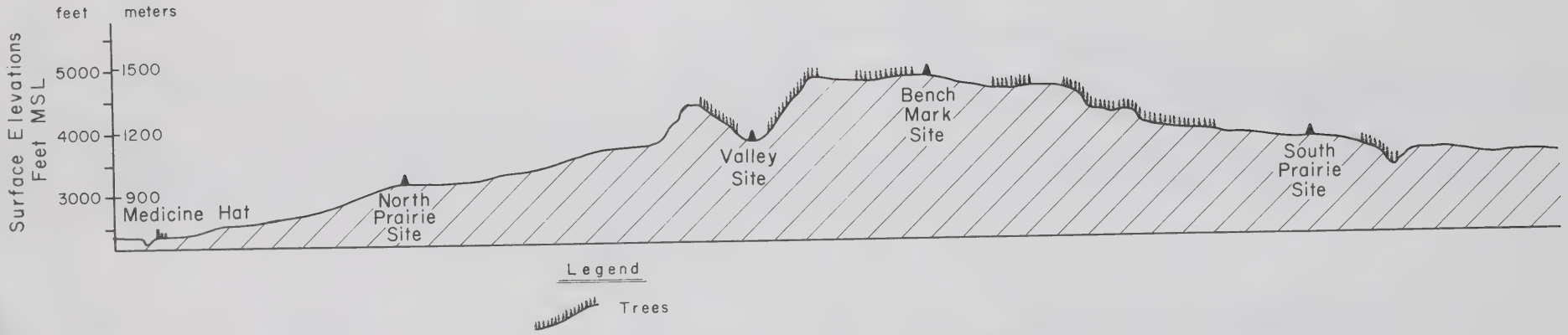
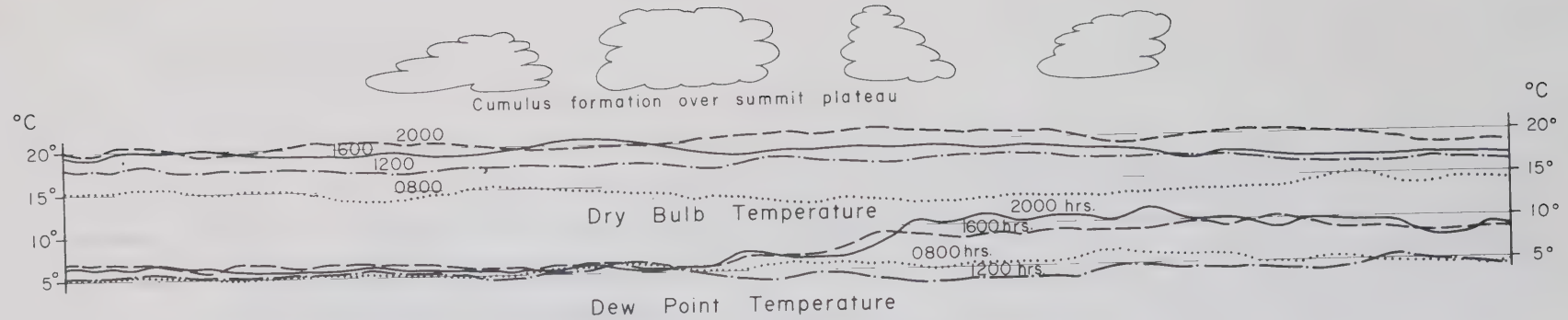


FIGURE 16 CYPRESS HILLS TRANSECT OF SURFACE AIR AND DEW POINT TEMPERATURE, JULY 19, 1967 1100 MST.



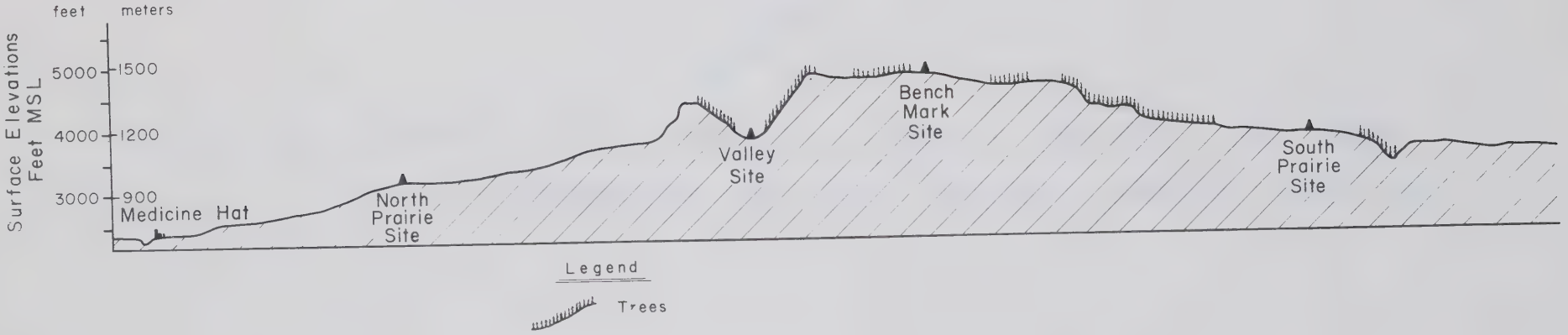


FIGURE 17 CYPRESS HILLS TRANSECT OF AIR AND DEW POINT TEMPERATURE AT VARIOUS TIMES ON JULY 19, 1967

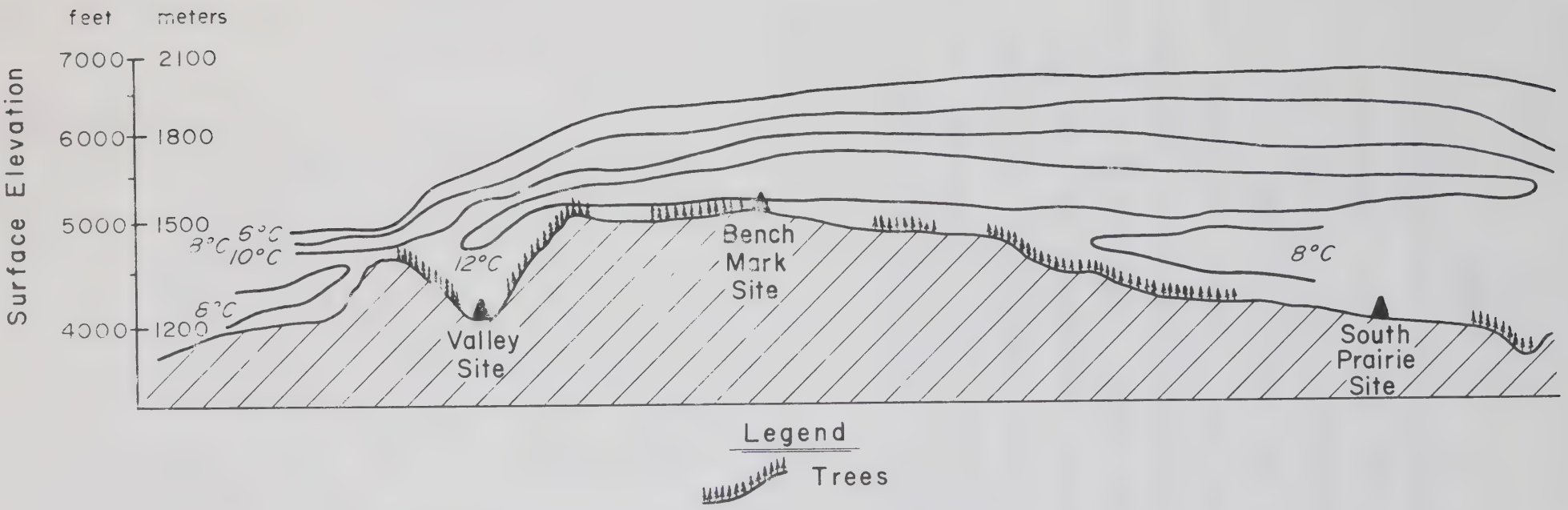


FIGURE 18 CYPRESS HILLS HEIGHT – DISTANCE TRANSECT OF DEW POINT TEMPERATURE ON JULY 22, 1967, 1500 TO 1650 MST.

Summary

Climatic studies described above were initiated in the Cypress Hills to study certain relationships between surface features and the atmosphere. This area is particularly interesting because of the unusual nature of the Cypress Hills land-form. This convenient and elevated area is cooler and more moist than the surrounding level prairie and consequently presents a unique surface biological-climatological environment. Further, the effects of the Hills can be measured in the atmosphere to a considerable height above the summit. Consequently, data are being obtained from surface sites as well as from an instrumented aircraft. The information will be used to relate quantitatively the climate to the nature of the surface.

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